



## Original communication

## Female hormone influences on sexual assaults in northern ireland from 2002 to 2009

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## ABSTRACT

In Northern Ireland 1 in every 454 women of 13 years and over during 2008/09 reported to police that they had suffered a sexual assault.<sup>1,2</sup> This study considered the possibility that women may be more likely to be victims of sexual assault during the fertile phase of their reproductive cycle. Evolutionary psychology suggests that women would have suffered more negative consequences if sexually assaulted when fertile and that specific psychological mechanisms may have evolved in women to combat male coercion. Female behaviours towards men vary across the reproductive cycle and men's behaviour towards women may vary also as a result of changes in female hormones. Hormones play a major role in producing the characteristic cyclical changes throughout a woman's reproductive life. This study is the first study of female hormone influences on sexual assaults. The data for the study was collated retrospectively from the records of 105 females with regular, spontaneous menstrual cycles. These females alleged recent sexual assault and were examined in Belfast during the period 2002–2009. The study concluded that young girls in the middle of their cycle, i.e. the fertile phase, were most at risk of sexual assault. It is possible that both sexes are sensitive to signs, albeit subtle behavioural signs, indicating high risk of conception.

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## 1. Introduction

As human evolutionary history has presented men and women with quite different reproductive problems to resolve, many of the resultant adaptations that have emerged are sex-specific. What is particularly note-worthy about human sexual adaptations, however, is that whereas male behaviour tends to be largely consistent over time, the factors that shape female mate preferences frequently show cyclic changes that correlate with phases of the menstrual cycle.<sup>3</sup> The dual mating theory (a strategy in which the female secured investment through one partner and obtained good genes through another) predicts that women will display greater interest in extra-pair sex near ovulation, a time of highest conception risk.<sup>4</sup>

Gangestad et al suggested that selection had probably forged adaptations in one or both sexes to be sensitive to conception risk.<sup>5</sup> It has been suggested that sexual selection would favour men who

could detect timing of ovulation as these men would have gained reproductive advantage by, for example, optimising their mating efforts by channelling courtship towards women in their ovulatory phase.<sup>6</sup> Several studies have reported that women feel more attractive and look more attractive during their ovulatory phase.<sup>7–9</sup> Other studies have reported that women experience a peak in sexual desire and become more flirtatious in the periovulatory period.<sup>10–12</sup>

Rape is a traumatic event that is likely to have been a recurrent problem for women over evolutionary history.<sup>13</sup> Human female fertility peaks in the early to mid-20's. As women in this age group are over-represented in reports of rape this may reflect a male adaptation.

The female reproductive cycle is a monthly cycle that begins and ends with menstruation. This cycle is a result of complex interactions between the hypothalamic – pituitary – ovarian endocrine axis. Follicle-stimulating hormone (one of two gonadotrophins secreted by the anterior pituitary gland) stimulates follicular cells to produce oestrogen. Oestrogen gradually rises in the post-menstrual phase with a surge at around day 12 of the cycle (day 1 = first day of menstruation). A luteinising hormone (second gonadotrophin) surge occurs after the oestrogen surge and triggers

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ovulation. Negative and positive feedback mechanisms help to control gonadotrophin secretion. The most fertile time in a woman's cycle or the time of highest conception risk extends from 2 days before until 2 days after ovulation. The accurate prediction of ovulation poses difficulties as there can be month-to-month variation in the length of the cycle. However the postovulatory phase of the cycle has a definitive length of 14 days and accordingly it is accepted that ovulation occurs on day 14 in a 28 day cycle.<sup>14</sup>

The objective of the study was to determine whether sexual assaults are more likely to occur during the high conception risk phase of the reproductive cycle. The study will also provide data for discussion which may help to prevent the occurrence of a sexual assault. It may help to identify areas of potential educational needs.

## 2. Materials & methods

### 2.1. Participants

#### 2.1.1. Study group

Participants consisted of 226 females of 13 years and over who alleged recent sexual assault. Fifteen participants were excluded from the analysis due to lack of consent for the use of their data. Females were required to be normally ovulating, i.e. not using any hormone based contraceptives; 49 participants were excluded for this reason (this included all pill users and those using long acting contraceptives or mirena systems). Twenty seven women had irregular cycles or cycles other than 28–30 days and also had to be excluded. Another 10 women were excluded, being either menopausal or having had a hysterectomy. Other reasons for removal from the study group included no record of last menstrual period, insufficient data regarding menstrual cycle regularity, ambiguous assault dates or contraceptive use unknown. These amounted to 17 participants. One participant was pregnant, 1 withdrew her allegation and 1 was a historical case. Ultimately the data analysis was performed on 105 females referred to as the 'Study' group. It was assumed that these females were normally ovulating and had a regular menstrual cycle.

#### 2.1.2. Control group

Of those females ineligible for inclusion in the study 13 females who were using a combined oral contraceptive pill were selected as a 'Control' group. Females who did not have a regular cycle or cases where data was insufficient were excluded. It was assumed that females in the Control group were not ovulating and had a regular menstrual cycle.

### 2.2. Procedure

The data for the study was collected retrospectively from consecutive cases between September 2002 and November 2009. Records from female sexual assault examinations at The Child Abuse and Rape Enquiry (CARE) Suite in Belfast were reviewed. Records were thoroughly examined to identify age, date of assault, menstrual cycle length and regularity, date of last menses, use of hormonal contraceptives and any other pertinent features.

Menstrual cycle information from the records was used to estimate the first day of the last menstrual period, i.e. day 1 of the reproductive cycle, by either forward or reverse cycle calculation. Next, the day of the cycle on which each sexual assault took place was deduced relative to 'day 1'.

For the purposes of the study it was assumed that ovulation corresponded to day 14 in those females with a 28 day cycle and day 16 in those females with a 30 day cycle.

Data from the records was transferred into basic spreadsheets. The results were all collated in a Microsoft Excel 2003 database. Graphs were obtained by Microsoft Excel.

All females presented to Police Service Northern Ireland and were assessed by a female Forensic Medical Officer. At the time of the assessment informed consent was obtained from each participant for the use of their data in research. Ages of females ranged from 13 years to 47 years.

### 2.3. Statistical analysis

To visually analyse the collected data scatter plots were produced for all the data and for the research and control groups so they could be directly compared. The age of victims, day of attack and number of attacks were all variables of interest. Pearson's correlation test,<sup>15</sup> which measures the strength of the linear relationship between two variables and is independent of the units the variables are measured in, was used to calculate the statistical significance between the age of the victim and the day of assault and also between the number of victims and day of assault for all data and for only the control group. A *t*-test<sup>15</sup> was used to test the hypothesis that there was no difference between the research and control groups. The significance level was set at  $p = 0.05$  for both Pearson's correlation and the *t*-test. A confidence interval of 95% was used which provides an estimate of the boundaries between which the true mean difference lies in 95% of all samples. The aim of this analysis was to assess the agreement between the day of cycle and number of attacks as well as determining if the age of the victim had any influence on the frequency of attacks or the day on which they occurred.

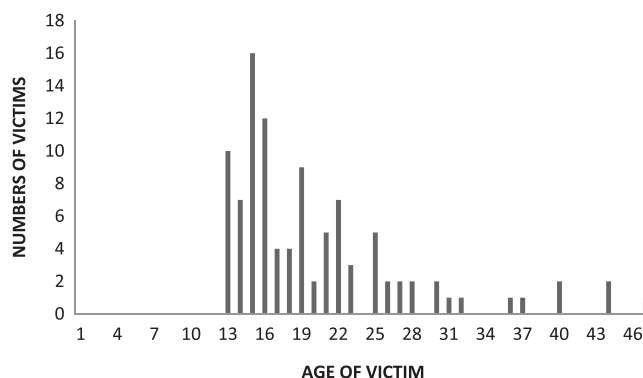
A non-parametric test in the form of Mann–Whitney analysis, which makes no assumption on the distribution of the data, was used to compare the control and research groups.

## 3. Results

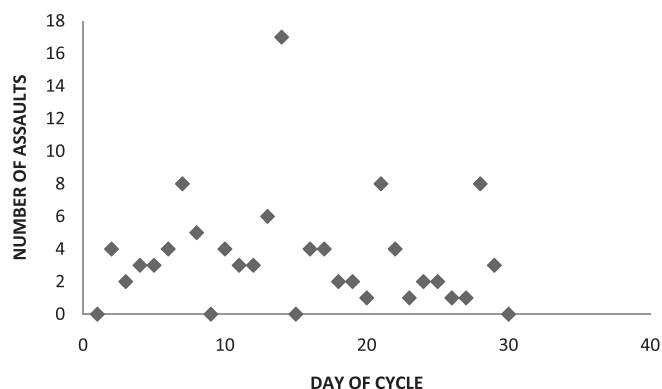
The mean age of a female in the Study group was 19.8 years and in the Control group 20.4 years. Assault victims were generally young with 85% of complainants aged 25 years or under with average age 21.03 years in the combined data (see Fig. 1).

Interesting results were obtained on preliminary analysis of data included in both the Study and Control group; scatter plot trends results (see Fig. 2) suggested that the majority of assaults took place mid-cycle, especially on day 14.

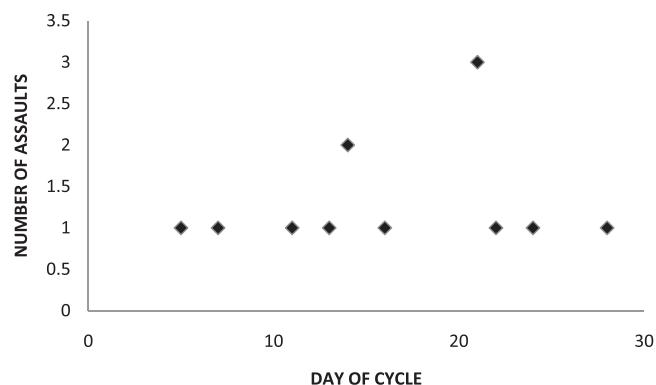
The trends in the data suggested that assaults appeared more likely to take place in the first half of the reproductive cycle. Dividing the cycle into 3 stages, early (days 1–10), mid (days 11–20) and late cycle (days 21–30) demonstrated 33 attacks occurred during the early cycle, 42 attacks during mid-cycle and 30 whilst the victim was in late cycle. Once again this implied mid-cycle was



**Fig. 1.** Age Distribution. A bar chart representing the distribution of ages of all victims of sexual assaults. The prevalence of younger victims can be clearly seen, with those under 25 years being most at risk.



**Fig. 2.** Combined Data/Number of Sexual Assaults. Numbers of sexual assaults occurring per day of cycle in the combined data of both study group and control group. Generally the volume of assaults is evenly scattered with a sharp increase in the middle of the cycle.



**Fig. 3.** Control Group/Number of Sexual Assaults. Numbers of sexual assaults occurring per day of cycle in the control group of females on a combined oral contraceptive pill. Again the spread of assaults is reasonably even but there are noticeable increases seen during the middle period of the cycle.

the most dangerous time with an attack around a third more likely in this period. A Pearson's correlation test was used to determine the statistical significance of relationships between the observed data values; day of the cycle and numbers of assaults. There was no statistical correlation between the day of the cycle and number of assaults occurring on that day, with  $p = 0.654$ . However this was likely to be due to the uneven spread of the number of assaults with such a high volume falling on day 14.

A further Pearson's correlation test measured the relationship between the age of victim and day of assault; the correlation coefficient in this case was 0.274 and not statistically significant. This implied that the victim would be highly likely to be young but did not influence the day on which they were attacked.

The data was then divided into a Study group and a Control group. The results from the Study group echoed those of the combined groups, as expected since it contained the majority of the samples. The smaller numbers included in the Control group made the data more difficult to interpret. Notably, the largest number of assaults occurred on day 21 and only the second largest number of assaults occurred on day 14 which showed the highest figures being attacked in the combined data (see Fig. 3).

A  $t$ -test was carried out to compare the results within the Study group and the Control group ( $p < 0.001$ ); this implied there were no significant differences between the two groups; being on the contraceptive pill did not therefore influence the day the assault occurred. A Pearson's correlation test was carried out on the control group and again the link between day and volume of attack was very insignificant with  $p = 0.642$ , which mirrored the lack of correlation in all data.

Almost one fifth (19.58%) of all assaults in the study group occurred from day 14 – day 16 (this denotes time of ovulation in a 28–30 day cycle), (see Fig. 4), again reinforcing that assaults were more likely around the middle of the cycle.

The Mann Whitney test returned a  $p$  value of 0.103 indicating there was no significant difference between the control and research group.

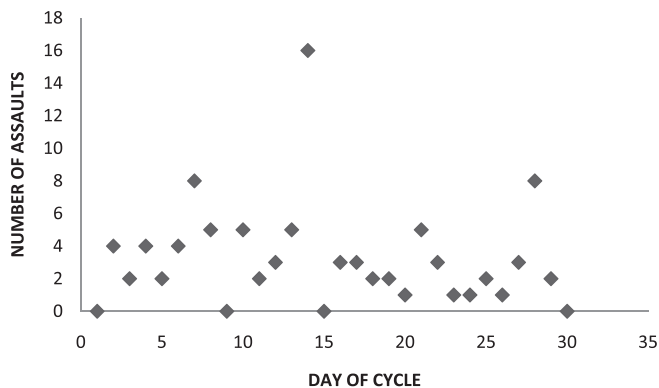
In conclusion there was no official significance between when an assault occurred and the day of cycle of the victim. However, analysing the bar and scatter plots it was apparent that there was a trend and a distinct rise in the number of assaults when the victims were in the middle of their cycle. Being on the pill or pill-free had no influence on the number of assaults or the day on which assaults occurred. Young girls in the middle of their cycle were those most at risk but this risk was not large enough to be classed as significantly different from young girls at other stages in their cycles.

#### 4. Discussion

This project failed to show any official statistical relationship between the higher conception risk phase of the reproductive cycle and the timing of a female sexual assault. Both the parametric and non-parametric tests indicated little difference in the distribution of attacks on women taking the pill and those who were not. However more than one third (>33.89%) of all assaults occurred at mid-cycle, i.e. between days 12 and 18 – this corresponds to the most fertile time in both 28 and 30 day cycles.

85% of complainants were 25 years of age or younger, i.e. at peak fertility. This might be explained by the evolutionary hypothesis of evolved psychological mechanisms causing rape; a rapist would be more likely to target a highly fertile female when reproductive success is at its highest.<sup>16</sup> However, these younger females may well be more sexually attractive in any case.

Rape is a traumatic event with severe consequences for women and, therefore, women may have evolved psychological mechanisms that motivate them to avoid circumstances linked with rape.<sup>16–18</sup> Identifying and assessing any specific rape avoidance behaviours should be beneficial in teaching effective rape avoidance and defence strategies. Broder and Hohmann confirmed that naturally cycling women reduced risky behaviours and increased non-risky ones during the ovulatory phase of their cycle.<sup>19</sup> Education of women about the reproductive cycle and estimation of the ovulatory phase with advice re avoidance of risky behaviour may have important consequences in the prevention of sexual assaults. Innate psychological processes and behavioural changes could be realised and intensified.



**Fig. 4.** Study Group/Number of Sexual Assaults. Numbers of sexual assaults occurring per day of cycle in the study group of normally ovulating females. Distribution levels match that of the combined data.

In one study specific behaviours were nominated by women in an effort to construct a Rape Avoidance Inventory. Four components were identified as follows; avoid strange men, avoid appearing sexually receptive, avoid being alone, and be more aware of surroundings/defensive preparedness. The performance of these behaviours was shown to be negatively associated with interest in and pursuit of short-term sex.<sup>16</sup> This is further evidence that education regarding changes in behaviour is critical in rape avoidance and prevention. Petralia and Gallup showed that women in the fertile phase of their cycle showed an increase in hand grip strength when presented with a sexual coercion scenario.<sup>20</sup> This could represent preparation for defence.

Alcohol and substance misuse and abuse will likely override any risk-management strategies. Unfortunately these are readily available and reduce the effectiveness of any psychological mechanisms which may have evolved to decrease risky behaviours during the periovulatory period. In one study in 2005 toxicology assays on blood or urine revealed that almost 80% of alleged sexual assaults were positive for alcohol or drugs or both.<sup>21</sup> A suggested fifth component of the Rape Avoidance Inventory could be: the avoidance of mind-altering drugs including alcohol. A female is more likely to become a victim of crime if she is drunk and vulnerable.

Rape is conditionally adopted by many men when its unconsciously perceived benefits exceed its costs; Thornhill and Palmer suggest that all human males have genes that might lead to raping behaviour if those genes interact with certain specific environmental factors during development.<sup>22</sup> All human females therefore need sound rape avoidance/prevention behaviours.

In conclusion, it appears that mid-cycle is the most risky phase. However the small sample sizes limit the conclusions that can be drawn from this study and confirmation is needed from further research. This has implications for female behaviour patterns and for education of women.

## 5. Limitations

One potential problem in this study is memory error concerning the date of last menstruation making the forward or reverse cycle method of calculation potentially unreliable. In addition, the experience of physical and/or psychological trauma is unique to each person and has the potential to erode capacity thereby contributing to memory errors.<sup>23</sup> Furthermore, participants may have been influenced by alcohol or drugs, although this information was not included in this study.

The day of ovulation in any cycle cannot be predicted with accuracy based on the length of previous cycles. Reverse cycle calculations based on the constant postovulatory or premenstrual phase are therefore more accurate than forward cycle calculations.<sup>14</sup>

Rape is grossly underreported. Is it possible that women in the periovulatory phase find rape to be more traumatic and therefore are they more likely to report it with a view to obtaining e.g. emergency contraception? Are periovulatory women more likely to resist attack, hence more likely to be injured and therefore need to seek help? This preliminary study may show a falsely high number of women at greatest conception risk.

## Conflict of interest statement

All authors declare there are no actual or potential conflicts of interest including any financial, personal or other relationships with other people or organizations within three (3) years of beginning the work submitted that could inappropriately influence (bias) their work.

## Funding

None.

## Ethical approval

None required. All information was anonymised, whilst specific details of the alleged events were absent. Every effort was made to ensure that personal identification could not take place by any reader.

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